

Institution	Collaboration		Base Program	Overall
	Committed (\$K)	Uncommitted (\$K)	Committed (\$K)	Total (\$K)
ANL	305	0	0	305
BNL	1818	0	1190	3008
FNAL [1]	1319	0	1423	2742
LBNL	440.5	184.5	299.9	740.4
Princeton U. [2]	221	59	187	408
UC-Berkeley	90	30	60	150
UCLA	130	0	78	208
Mississippi	32	36	32	64
<i>Cornell + NSF Contracts</i>	<i>243.6</i>	<i>950.0</i>	<i>0</i>	<i>243.6</i>
TOTALS [3]	4355.5	309.5	3269.9	7625.4

1259.5

NOTES:

[1] Includes \$157K IIT subcontract.

[2] Includes \$40K carryover from FY99.

[3] DOE totals in Roman type; *additional NSF funding shown in italics*



M. Zisman
Project Manager

Institution: Argonne National Laboratory

Task	Muon Collaboration Funds			Laboratory Funds		
	Effort (\$K)	M&S (\$K)	Sum (\$K)	Effort (\$K)	M&S (\$K)	Sum (\$K)
<u>Targetry Studies</u>						
Liquid Target Studies	\$ 80.000		\$ 80.000			
<u>Cooling Studies</u>						
Lithium Lens						
Cavity X-rays		\$25.000	\$25.000			
<u>Physics Salaries</u>						
Cooling (Cav. X-rays, Diagnostics)	\$ 180.000		\$ 180.000			
Theory	\$ 20.000		\$ 20.000			
<u>Administration and Travel</u>						
SUBTOTALS	\$ 280.000	\$ 25.000		\$ -	\$ -	
TOTALS			\$ 305.000			\$ -

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7:42 PM

**Argonne National Laboratory
(Accomplishments–FY2000)**

- Developed general analytic expression for beam optics in solenoid focusing channel
- Completed measurements of the x-ray spectrum from an RF cavity to assess its effect on the diagnostics envisioned for the proposed FNAL muon cooling experiment; found large x-ray flux that precludes most single-particle detection apparatus considered previously
- Described possible method for bunched-beam muon cooling demonstration that is compatible with cavity x-ray flux
- Developed analytical model for study of beam and electromagnetic heating in solid and free-liquid-jet targets, including oscillations and fragmentation effects; used the code to identify reflected shocks as a potentially lifetime-limiting mechanism



M. Zisman
Project Manager

Institution: Brookhaven National Laboratory

Task	Muon Collaboration Funds			Laboratory Funds		
	Effort (\$K)	M&S (\$K)	Sum (\$K)	Effort (\$K)	M&S (\$K)	Sum (\$K)
<u>Targetry Studies</u>						
AGS Beamline Preparation	\$ 103.0	\$ 1,145.0	\$ 1,248.0			
Magnetic Systems	\$ 173.0	\$ 10.0	\$ 183.0			
RF System Studies	\$ 194.0	\$ 193.0	\$ 387.0			
<u>Engineering Salaries</u>						
<u>Physics Salaries</u>						
Targetry				\$ 283.0	\$19.0	\$ 302.0
Cooling				\$ 325.0		\$ 325.0
Acceleration				\$ 29.0		\$ 29.0
Storage Ring				\$ 128.0		\$ 128.0
Collaboration Management				\$ 93.0		\$ 93.0
<u>Administration and Travel</u>				\$ 119.0	\$ 194.0	\$ 313.0
SUBTOTALS	\$ 470.0	\$ 1,348.0		\$ 977.0	\$ 213.0	
TOTALS			\$ 1,818.0			\$ 1,190.0

Printed: November 20, 2000
7:42 PM

**Brookhaven National Laboratory
(Accomplishments–FY2000)**

- Continued development of main simulation program used by Collaboration for front-end channel design (ICOOL); added emittance exchange tools, an induction linac routine, and facilities for analysis of muon polarization
- Sponsored Collaboration workshop on emittance exchange
- Defined initial design concepts for Neutrino Factory Feasibility Study-II that serve as baseline for continued simulation effort
- Completed preparations for possible future test of 70 MHz RF cavity near the target, including infrastructure for testing and commissioning the RF power supply, infrastructure for delivering RF power to the A3 beam line, and development of a mechanical design for a 70 MHz RF test cavity
- Continued preparation of A3 target test beam line; all magnets are installed and tested, and the shielding and required beam line instrumentation are nearing completion
- Completed magnetic design for E951 20-T pulsed solenoid
- Developed designs for initial test targets (both solid and liquid)
- Received formal DOE approval for AGS E951 Targetry Experiment

Institution Fermi National Accelerator Laboratory

Task	Muon Collaboration Funds			Laboratory Funds		
	Effort (\$K)	M&S (\$K)	Sum (\$K)	Effort (\$K)	M&S (\$K)	Sum (\$K)
<u>MUCOOL Studies</u>						
Cooling Channel Design				\$22.000	\$37.000	\$59.000
Solenoid Studies						
RF System Studies						
High-Power Cav. + Test Facil. (805 MHz)	\$ 345.000	\$ 581.000	\$ 926.000			
High-Power Cavity (201 MHz)						
Diagnostics Development	\$ 24.000	\$ 36.000	\$ 60.000		\$38.000	\$38.000
<u>Feasibility Study</u>						
Design Studies		\$ 333.000	\$ 333.000	\$111.000	\$8.000	\$119.000
<u>Simulation Studies</u>						
Capture + Cooling				\$799.000		\$799.000
<u>Travel and General Operations</u>						
Travel						
Operations				\$176.000	\$232.000	\$408.000
SUBTOTALS	\$ 369.000	\$ 950.000		\$1,108.000	\$315.000	
TOTALS			\$1,319.000			\$1,423.000

**Fermi National Accelerator Laboratory
(Accomplishments–FY2000)**

- Completed detailed report summarizing Neutrino Factory Feasibility Study-I; demonstrated technical feasibility of entry level Neutrino Factory design
- Completed Lab G test facility, including x-ray cave, installation and testing of 805 MHz RF power system, and installation and testing of LBNL-built superconducting solenoid
- Completed fabrication and measurements of an aluminum model of an open-cell 805 MHz test cavity
- Completed fabrication, bead-pull measurements, and tuning of 805-MHz copper open-cell cavity in preparation for high-power testing in Lab G test facility
- In collaboration with Illinois Institute of Technology staff, completed design of a liquid hydrogen absorber prototype and developed specifications for a test facility to be completed during FY2001
- Carried out engineering studies for several candidate cooling channel designs
- Carried out cooling channel simulation studies and began using GEANT4 as a tool for this purpose
- Continued R&D on very fast timing devices for potential use as cooling channel beam diagnostics
- Began participation in Neutrino Factory Feasibility Study-II



M. Zisman
Project Manager

Institution: E. O. Lawrence Berkeley National Laboratory

Task	Muon Collaboration Funds			Laboratory Funds		
	Effort (\$K)	M&S (\$K)	Sum (\$K)	Effort (\$K)	M&S (\$K)	Sum (\$K)
<u>MUCOOL Studies</u>						
Solenoid Studies (805 MHz)	\$ 16.716	\$ 33.787	\$ 50.503			
Solenoid Studies (201 MHz)	\$ 59.642	\$ 1.256	\$ 60.898			
RF System Studies						
Be Window Design	\$ 37.868	\$ 11.037	\$ 48.905			
Low-Power Cavity (805 MHz)	\$ 2.870	\$ 0.306	\$ 3.176			
High-Power Pillbox (805 MHz)	\$ 14.416	\$ 1.137	\$ 15.553			
<u>Targetry Studies</u>						
RF Amplifier Tests (70 MHz)	\$ 70.240	\$ 105.345	\$ 175.585			
<u>Induction Linac Studies</u>	\$ 65.803	\$ 13.444	\$ 79.247			
<u>Physics Salaries</u>						
RF System Studies				\$ 67.500		\$ 67.500
Management				\$ 216.462	\$ 8.969	\$ 225.431
<u>Administration and Travel</u>		\$ 6.664	\$ 6.664		\$ 6.927	\$ 6.927
SUBTOTALS	\$ 267.555	\$ 172.976		\$283.962	\$15.896	
TOTALS			\$ 440.531			\$299.858

Uncommitted	Muon Collaboration Funds		
	Effort (\$K)	M&S (\$K)	Sum (\$K)
<u>Carryover</u>		\$184.49	\$ 184.49
SUBTOTALS	\$ -	\$ 184.49	
TOTALS			\$ 184.49

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7:42 PM



M. Zisman
Project Manager

**Lawrence Berkeley National Laboratory
(Accomplishments–FY2000)**

- Completed shipping to FNAL, and testing in Lab G, a two-coil solenoid for 805 MHz cooling cell component tests
- Began investigation of design concepts for test solenoid suitable for 201 MHz component testing
- Completed low-power test cavity measurements at room temperature and at liquid-nitrogen temperature
- Continued analysis of Be windows, including finite-element analysis
- Completed design of a high-power 805 MHz pillbox cavity in preparation for fabrication at University of Mississippi
- Continued refurbishment of SuperHILAC 70 MHz RF source
- Completed conceptual design of induction linac for Feasibility Study-I report
- Participating in Neutrino factory Feasibility Study-II
- Began development of visualization tools for the front-end simulation effort
- Carrying out management tasks for Collaboration, including providing Collaboration Spokesperson and Project Manager, and carrying out accounting and budgeting activities

Printed: November 20, 2000
7:42 PM



M. Zisman
Project Manager

Institution: Princeton University

Task	Muon Collaboration Funds			Base Program Funds		
	Effort (\$K)	M&S (\$K)	Sum (\$K)	Effort (\$K)	M&S (\$K)	Sum (\$K)
<u>Targetry Studies</u>						
Design	\$ 42.00	\$ 6.00	\$ 48.00	\$ 135.00		\$ 135.00
Fabrication	\$ 5.00	\$ 5.00	\$ 10.00			
Diagnostics		\$ 81.00	\$ 81.00			
Simulations		\$ 6.00	\$ 6.00			
<u>Physics Salaries</u>						
Simulations	\$ 60.00		\$ 60.00			
Target				\$ 40.00		\$ 40.00
<u>Administration and Travel</u>		\$ 16.00	\$ 16.00		\$ 12.00	\$ 12.00
SUBTOTALS	\$ 107.00	\$ 114.00		\$ 175.00	\$ 12.00	
TOTALS			\$ 221.00			\$ 187.00

Uncommitted	Muon Collaboration Funds		
	Effort (\$K)	M&S (\$K)	Sum (\$K)
<u>Carryover</u>		\$59.00	\$ 59.00
SUBTOTALS	\$ -	\$ 59.00	
TOTALS			\$ 59.00

Printed: November 20, 2000
7:42 PM



M. Zisman
Project Manager

**Princeton University
(Accomplishments–FY2000)**

- Continued overall coordination of targetry R&D effort
- Obtained approval from BNL for targetry experiment E951; MOU preparation is in progress
- Prepared initial complement of target cells for E951 testing
- Began design of optical diagnostic system capable of operating outside of high-radiation area
- Carried out initial ANSYS calculations of a pulsed mercury jet target
- Participated in Neutrino Factory Feasibility Studies I and II
- Carried out beam theoretical activities on excitation of beam-plasma instabilities in the ionization cooling parameter regime; paper accepted by Physical Review Letters



M. Zisman
Project Manager

Institution: University of California–Berkeley

Task	Muon Collaboration Funds			Base Program Funds		
	Effort (\$K)	M&S (\$K)	Sum (\$K)	Effort (\$K)	M&S (\$K)	Sum (\$K)
<u>Physics Salaries</u>						
Cooling Simulations	\$ 84.0		\$ 84.0	\$ 54.0		\$ 54.0
<u>Administration and Travel</u>		\$ 6.0	\$ 6.0		\$ 6.0	\$ 6.0
SUBTOTALS	\$ 84.0	\$ 6.0		\$ 54.0	\$ 6.0	
TOTALS			\$ 90.0			\$ 60.0

Uncommitted	Muon Collaboration Funds		
	Effort (\$K)	M&S (\$K)	Sum (\$K)
<u>Carryover</u>	\$ 30.00		\$ 30.00
SUBTOTALS	\$ 30.00		
TOTALS			\$ 30.00

Printed: November 20, 2000
7:42 PM



M. Zisman
Project Manager

**University of California–Berkeley
(Accomplishments–FY2000)**

- Continued coordination role for Collaboration Beam Simulation and Theory Group effort, including development of R&D plan for MUTAC
- Participated in Neutrino Factory Feasibility Study-I simulation effort and coordinated weekly phone conferences
- Completed development of analytic theory of transverse optics in a solenoid channel (analogous to the Courant-Snyder formalism for storage rings) and published a paper
- Developed beam quality “diagnostics” for the ICOOL code
- Developing visualization tools to aid in interpreting ICOOL results
- Participated in organization of NUFACT’00 International Workshop, held in Monterey, CA



M. Zisman
Project Manager

Institution: University of California–Los Angeles

Task	Muon Collaboration Funds			Base Program Funds		
	Effort (\$K)	M&S (\$K)	Sum (\$K)	Effort (\$K)	M&S (\$K)	Sum (\$K)
<u>Cooling Studies</u>						
Diagnostics development	\$ 28.703		\$ 28.703	\$ 20.440		\$ 20.440
<u>Physics Salaries</u>						
Cooling Channel Simulations	\$ 84.623		\$ 84.623			
Lattice Studies				\$ 10.660		\$ 10.660
<u>Administration and Travel</u>		\$ 16.674	\$ 16.674	\$ 16.580	\$ 30.335	\$ 46.915
SUBTOTALS	\$ 113.326	\$ 16.674		\$ 47.680	\$ 30.335	
TOTALS			\$ 130.000			\$78.015

Printed: November 20, 2000
7:42 PM

**University of California–Los Angeles
(Accomplishments–FY2000)**

- Carried out simulations for various aspects of the Neutrino Factory design, including front-end cooling studies, phase rotation optimization, emittance-exchange schemes, polarization preservation, and storage ring neutrino flux
- Carried out simulations for E951 Targetry Experiment, examining the effectiveness of the initial RF cavity phase rotation scheme to increase yield and/or polarization and also assessing the radiation environment in the area where the experiment detectors will be located
- In collaboration with FNAL staff, continued development of a 10-ps fast timing system and studied its application for beam monitoring
- Studied lattice concepts for a Neutrino Factory storage ring, particularly the so-called “bow tie” configuration that can serve multiple baselines, and looked at FFAG acceleration options
- Participating in study of WIPP site (Carlsbad, NM) as a location for a Neutrino Factory detector
- Participating in MUSCAT experiment at TRIUMF in collaboration with the RAL group; work included building and commissioning the S1 time-of-flight system, setting up the experiment, working shifts, and participating in data analysis
- Carried out initial considerations for frictional cooling in a plasma, which would avoid electron and proton capture losses of the muon beam
- Organized Fifth International Muon Collider and Neutrino Factory Conference (December 1999) and Collaboration meeting in Catalina (May 2000)



M. Zisman
Project Manager

Institution: University of Mississippi

Task	Muon Collaboration Funds			Base Program Funds		
	Effort (\$K)	M&S (\$K)	Sum (\$K)	Effort (\$K)	M&S (\$K)	Sum (\$K)
<u>Cooling Studies</u>						
Simulations		\$ 8.000	\$ 8.000			
805-MHz RF Cavity Fabrication	\$ 12.000	\$ 2.000	\$ 14.000			
<u>Physics Salaries</u>						
Cooling Studies				\$ 32.00		\$ 32.00
RF Cavity						
Be Window Studies						
<u>Administration and Travel</u>		\$ 10.000	\$ 10.000			
SUBTOTALS	\$ 12.000	\$ 20.000		\$32.000	\$	
TOTALS			\$ 32.000			\$32.000

Uncommitted	Muon Collaboration Funds		
	Effort (\$K)	M&S (\$K)	Sum (\$K)
<u>Carryover</u>	\$ 36.00		\$ 36.00
SUBTOTALS	\$ 36.00		
TOTALS			\$ 36.00

Printed: November 20, 2000
7:42 PM

**University of Mississippi
(Accomplishments–FY2000)**

- Completed development of OPTICOOL “wrapper” for ICOOL code; the code can optimize a cooling channel for a user-defined figure of merit using an n -parameter simplex algorithm, and it can run problems on a Linux computer farm
- Continued preparations to fabricate an 805-MHz high-power test cavity being designed by LBNL; machining techniques are being developed, cleaning processes are being defined, and vendor site visits are taking place in preparation for fabrication in FY2001
- Continuing investigation of beryllium properties, with the aim of measuring resistivity of annealed beryllium strips
- Continued design effort for Cherenkov counters to distinguish muons from electrons or pions for the MUCOOL program; GEANT simulations of Teflon-AF were carried out, and investigation of aerogel devices is getting under way